

(incorporated by reference; see §430.3), and the fossil fuel energy consumption during the off mode test,  $Q_{\text{off}}$  ( $= Q_p$ ), in Btu. Ambient temperature and voltage specifications of ANSI Z21.56 (incorporated by reference; see §430.3) shall apply to this off mode testing. The recorded off mode power ( $P_{\text{W,OFF}}$ ) shall be rounded to the second decimal place, and for loads greater than or equal to 10W, at least three significant figures shall be reported.

#### 5. Calculations.

5.1 *Thermal efficiency.* Calculate the thermal efficiency,  $E_t$  (expressed as a percent), as specified in section 2.10 of ANSI Z21.56 (incorporated by reference; see §430.3). The expression of fuel consumption for oil-fired pool heaters shall be in Btu.

5.2 *Average annual fossil fuel energy for pool heaters.* The average annual fuel energy for pool heaters,  $E_F$ , is defined as:

$$E_F = \text{BOH } Q_{\text{IN}} + (\text{POH} - \text{BOH})Q_{\text{PR}} + (8760 - \text{POH}) Q_{\text{off,R}}$$

Where:

BOH = average number of burner operating hours = 104 h

POH = average number of pool operating hours = 4464 h

$Q_{\text{IN}}$  = rated fuel energy input as defined according to section 2.10.1 or section 2.10.2 of ANSI Z21.56, as appropriate.

$Q_{\text{PR}}$  = average energy consumption rate of continuously operating pilot light, if employed,  $= (Q_p/1 \text{ h})$

$Q_p$  = energy consumption of continuously operating pilot light, if employed, as measured in section 4.2 of this appendix, in Btu

8760 = number of hours in one year

$Q_{\text{off,R}}$  = average off mode fossil fuel energy consumption rate  $= Q_{\text{off}}/(1 \text{ h})$

$Q_{\text{off}}$  = off mode energy consumption as defined in section 4.3 of this appendix

5.3 *Average annual auxiliary electrical energy consumption for pool heaters.* The average annual auxiliary electrical energy consumption for pool heaters,  $E_{\text{AE}}$ , is expressed in Btu and defined as:

$$(1) E_{\text{AE}} = E_{\text{AE,active}} + E_{\text{AE,standby,off}}$$

$$(2) E_{\text{AE,active}} = \text{BOH} * \text{PE}$$

$$(3) E_{\text{AE,standby,off}} = (\text{POH} - \text{BOH}) P_{\text{W,SB}}(\text{Btu/h}) + (8760 - \text{POH}) P_{\text{W,OFF}}(\text{Btu/h})$$

Where:

$E_{\text{AE,active}}$  = auxiliary electrical consumption in the active mode

$E_{\text{AE,standby,off}}$  = auxiliary electrical consumption in the standby mode and off mode

PE =  $2E_c$ , if heater is tested according to section 2.10.1 of ANSI Z21.56, in Btu/h =  $3.412 P_{\text{E,rated}}$ , if heater is tested according to section 2.10.2 of ANSI Z21.56, in Btu/h

$E_c$  = electrical consumption of the heater (converted to equivalent unit of Btu), including the electrical energy to the recirculating pump if used, during the 30-minute thermal efficiency test, as de-

finied in section 2.10.1 of ANSI Z21.56, in Btu per 30 min.

2 = conversion factor to convert unit from per 30 min. to per h.

$P_{\text{E,rated}}$  = nameplate rating of auxiliary electrical equipment of heater, in Watts

BOH = as defined in 5.2 of this appendix

POH = as defined in 5.2 of this appendix

$P_{\text{W,SB}}$  (Btu/h) = electrical energy consumption rate during standby mode expressed in Btu/h =  $3.412 P_{\text{W,SB}}$ , Btu/h

$P_{\text{W,SB}}$  = as defined in 4.2 of this appendix

$P_{\text{W,OFF}}$  (Btu/h) = electrical energy consumption rate during off mode expressed in Btu/h =  $3.412 P_{\text{W,OFF}}$ , Btu/h

$P_{\text{W,OFF}}$  = as defined in 4.3 of this appendix

5.4 Integrated thermal efficiency.

5.4.1 Calculate the seasonal useful output of the pool heater as:

$$E_{\text{OUT}} = \text{BOH}[(E_t/100)(Q_{\text{IN}} + \text{PE})]$$

Where:

BOH = as defined in 5.2 of this appendix

$E_t$  = thermal efficiency as defined in 5.1 of this appendix

$Q_{\text{IN}}$  = as defined in 5.2 of this appendix

PE = as defined in 5.3 of this appendix

100 = conversion factor, from percent to fraction

5.4.2 Calculate the annual input to the pool heater as:

$$E_{\text{IN}} = E_F + E_{\text{AE}}$$

Where:

$E_F$  = as defined in 5.2 of this appendix

$E_{\text{AE}}$  = as defined in 5.3 of this appendix

5.4.3 Calculate the pool heater integrated thermal efficiency ( $TE_i$ ) (in percent).

$$TE_i = 100(E_{\text{OUT}}/E_{\text{IN}})$$

Where:

$E_{\text{OUT}}$  = as defined in 5.4.1 of this appendix

$E_{\text{IN}}$  = as defined in 5.4.2 of this appendix

100 = conversion factor, from fraction to percent

[77 FR 74572, Dec. 17, 2012]

### APPENDIX Q TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF FLUORESCENT LAMP BALLASTS

Comply with Appendix Q until November 14, 2014. After this date, all fluorescent lamp ballasts shall be tested using the provisions of Appendix Q1.

#### 1. Definitions

1.1 *AC control signal* means an alternating current (AC) signal that is supplied to the ballast using additional wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

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## Pt. 430, Subpt. B, App. Q

1.2 *ANSI Standard* means a standard developed by a committee accredited by the American National Standards Institute.

1.3 *Ballast input voltage* means the rated input voltage of a fluorescent lamp ballast.

1.4 *DC control signal* means a direct current (DC) signal that is supplied to the ballast using additional wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

1.5 *F40T12 lamp* means a nominal 40 watt tubular fluorescent lamp which is 48 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881-ANSI-1010-1) (incorporated by reference; see § 430.3).

1.6 *F96T12 lamp* means a nominal 75 watt tubular fluorescent lamp which is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881-ANSI-3007-1) (incorporated by reference; see § 430.3).

1.7 *F96T12HO lamp* means a nominal 110 watt tubular fluorescent lamp that is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881-ANSI-1019-1) (incorporated by reference; see § 430.3).

1.8 *F34T12 lamp* (also known as a “F40T12/ES lamp”) means a nominal 34 watt tubular fluorescent lamp that is 48 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881-ANSI-1006-1) (incorporated by reference; see § 430.3).

1.9 *F96T12/ES lamp* means a nominal 60 watt tubular fluorescent lamp that is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881-ANSI-3006-1) (incorporated by reference; see § 430.3).

1.10 *F96T12HO/ES lamp* means a nominal 95 watt tubular fluorescent lamp that is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881-ANSI-1017-1) (incorporated by reference; see § 430.3).

1.11 *Input current* means the root-mean-square (RMS) current in amperes delivered to a fluorescent lamp ballast.

1.12 *Luminaire* means a complete lighting unit consisting of a fluorescent lamp or lamps, together with parts designed to distribute the light, to position and protect such lamps, and to connect such lamps to the power supply through the ballast.

1.13 *Nominal lamp watts* means the wattage at which a fluorescent lamp is designed to operate.

1.14 *PLC control signal* means a power line carrier (PLC) signal that is supplied to the ballast using the input ballast wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

1.15 *Power Factor* means the power input divided by the product of ballast input voltage and input current of a fluorescent lamp bal-

last, as measured under test conditions specified in ANSI C82.2 (incorporated by reference; see § 430.3).

1.16 *Power input* means the power consumption in watts of a ballast a fluorescent lamp or lamps, as determined in accordance with the test procedures specified in ANSI C82.2 (incorporated by reference; see § 430.3).

1.17 *Relative light output* means the light output delivered through the use of a ballast divided by the light output of a reference ballast, expressed as a percent, as determined in accordance with the test procedures specified in ANSI C82.2 (incorporated by reference; see § 430.3).

1.18 *Residential building* means a structure or portion of a structure which provides facilities or shelter for human residency, except that such term does not include any multifamily residential structure of more than three stores above grade.

1.19 *Standby mode* means the condition in which an energy-using product—

(a) Is connected to a main power source; and

(b) Offers one or more of the following user-oriented or protective functions:

(i) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer.

(ii) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

1.20 *Wireless control signal* means a wireless signal that is radiated to and received by the ballast for the purpose of controlling the ballast and putting the ballast in standby mode.

### 2. Test Conditions.

2.1 *Measurement of Active Mode Energy Consumption, BEF.* The test conditions for testing fluorescent lamp ballasts shall be done in accordance with ANSI C82.2 (incorporated by reference; see § 430.3). Any subsequent amendment to this standard by the standard setting organization will not affect the DOE test procedures unless and until amended by DOE. The test conditions for measuring active mode energy consumption are described in sections 4, 5, and 6 of ANSI C82.2. The test conditions described in this section (2.1) are applicable to section 3.1 of section 3, Test Method and Measurements. For section 2.1 and 3, ANSI C78.81 (incorporated by reference; see § 430.3), ANSI C82.1 (incorporated by reference; see § 430.3), ANSI C82.11 (incorporated by reference; see § 430.3), and ANSI C82.13 (incorporated by reference; see § 430.3) shall be used when applying ANSI C82.2 instead of the versions listed as normative references in ANSI C82.2.

2.2 *Measurement of Standby Mode Power.* The measurement of standby mode power need not be performed to determine compliance with energy conservation standards for fluorescent lamp ballasts at this time. This and the previous statement will be removed

as part of a rulemaking to amend the energy conservation standards for fluorescent lamp ballasts to account for standby mode energy consumption, and the following shall apply on the compliance date for any such requirements.

The test conditions for testing fluorescent lamp ballasts shall be done in accordance with ANSI C82.2 (incorporated by reference; see § 430.3). Any subsequent amendment to this standard by the standard setting organization will not affect the DOE test procedures unless and until amended by DOE. The test conditions for measuring standby power are described in sections 5, 7, and 8 of ANSI C82.2. Fluorescent lamp ballasts that are capable of connections to control devices shall be tested with all commercially available compatible control devices connected in all possible configurations. For each configuration, a separate measurement of standby power shall be made in accordance with section 3.2 of the test procedure.

### 3. TEST METHOD AND MEASUREMENTS

#### 3.1 Active Mode Energy Efficiency Measurement

3.1.1 The test method for testing the active mode energy efficiency of fluorescent lamp ballasts shall be done in accordance with ANSI C82.2 (incorporated by reference; see § 430.3). Where ANSI C82.2 references ANSI C82.1-1997, the operator shall use ANSI C82.1 (incorporated by reference; see § 430.3) for testing low-frequency ballasts and ANSI C82.11 (incorporated by reference; see § 430.3) for high-frequency ballasts.

3.1.2 *Instrumentation*. The instrumentation shall be as specified by sections 5, 7, 8, and 15 of ANSI C82.2 (incorporated by reference; see § 430.3).

##### 3.1.3 *Electric Supply*.

3.1.3.1 *Input Power*. Measure the input power (watts) to the ballast in accordance

with ANSI C82.2 (incorporated by reference; see § 430.3), section 4.

3.1.3.2 *Input Voltage*. Measure the input voltage (volts) (RMS) to the ballast in accordance with ANSI C82.2 (incorporated by reference; see § 430.3), section 3.2.1 and section 4.

3.1.3.3 *Input Current*. Measure the input current (amps) (RMS) to the ballast in accordance with ANSI C82.2 (incorporated by reference; see § 430.3), section 3.2.1 and section 4.

##### 3.1.4 *Light Output*.

3.1.4.1 Measure the light output of the reference lamp with the reference ballast in accordance with ANSI C82.2 (incorporated by reference; see § 430.3), section 12.

3.1.4.2 Measure the light output of the reference lamp with the test ballast in accordance with ANSI C82.2 (incorporated by reference; see § 430.3), section 12.

### 3.2 Standby Mode Power Measurement

3.2.1 The test for measuring standby mode energy consumption of fluorescent lamp ballasts shall be done in accordance with ANSI C82.2 (incorporated by reference; see § 430.3).

3.2.2 Send a signal to the ballast instructing it to have zero light output using the appropriate ballast communication protocol or system for the ballast being tested.

3.2.3 *Input Power*. Measure the input power (watts) to the ballast in accordance with ANSI C82.2-2002, section 13, (incorporated by reference; see § 430.3).

3.2.4 *Control Signal Power*. The power from the control signal path will be measured using all applicable methods described below.

3.2.4.1 *AC Control Signal*. Measure the AC control signal power (watts), using a wattmeter (W), connected to the ballast in accordance with the circuit shown in Figure 1.

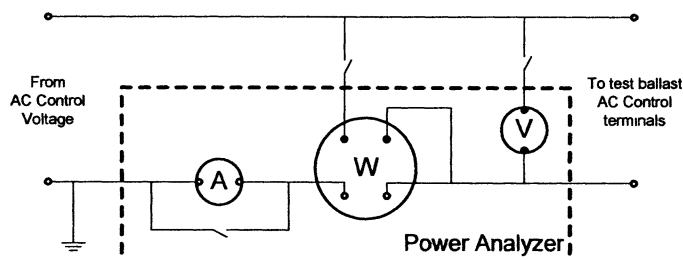


Figure 1: Circuit for Measuring AC Control Signal Power in Standby Mode

3.2.4.2 *DC Control Signal.* Measure the DC control signal voltage, using a voltmeter (V), and current, using an ammeter (A), connected to the ballast in accordance with the

circuit shown in Figure 2. The DC control signal power is calculated by multiplying the DC control signal voltage and the DC control signal current.

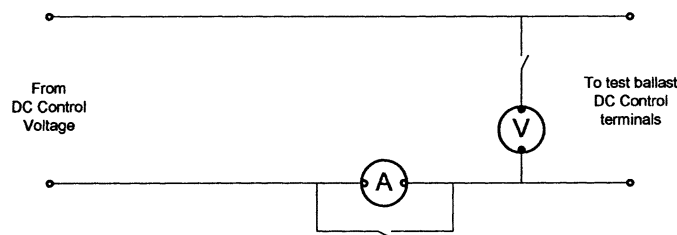


Figure 2: Circuit for Measuring DC Control Signal Power in Standby Mode

3.2.4.3 *Power Line Carrier (PLC) Control Signal.* Measure the PLC control signal power (watts), using a wattmeter (W), connected to the ballast in accordance with the circuit shown in Figure 3. The wattmeter must have

a frequency response that is at least 10 times higher than the PLC being measured in order to measure the PLC signal correctly. The wattmeter must also be high-pass filtered to filter out power at 60 Hertz.

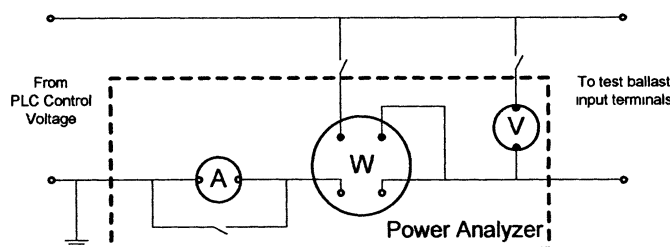


Figure 3: Circuit for Measuring PLC Control Signal Power in Standby Mode

3.2.4.4 *Wireless Control Signal.* The power supplied to a ballast using a wireless signal is not easily measured, but is estimated to be well below 1.0 watt. Therefore, the wire-

less control signal power is not measured as part of this test procedure.

#### 4. Calculations.

##### 4.1 Calculate relative light output:

$$\text{relative light output} = \frac{\text{Photocell output of lamp on test ballast}}{\text{Photocell output of lamp on reference ballast}} \times 100$$

Where: photocell output of lamp on test ballast is determined in accordance with section 3.1.4.2, expressed in watts, and photocell output of lamp on ref. ballast is determined

in accordance with section 3.1.4.1, expressed in watts.

#### 4.2. Determine the Ballast Efficacy Factor (BEF) using the following equations:

##### (a) Single lamp ballast

$$BEF = \frac{\text{relative light output}}{\text{input power}}$$

(b) Multiple lamp ballast

$$BEF = \frac{\text{average relative light output}}{\text{input power}}$$

Where:

Input power is determined in accordance with section 3.1.3.1, relative light output as defined in section 4.1, and average relative light output is the relative light

output, as defined in section 4.1, for all lamps, divided by the total number of lamps.

4.3 Determine Ballast Power Factor (PF):

$$PF = \frac{\text{Input power}}{\text{Input voltage} \times \text{input current}}$$

Where:

Input power is as defined in section 3.1.3.1, Input voltage is determined in accordance with section 3.1.3.2, expressed in volts, and Input current is determined in accordance with section 3.1.3.3, expressed in amps.

[54 FR 6076, Feb. 7, 1989, as amended at 56 FR 18682, Apr. 24, 1991; 69 FR 18803, Apr. 9, 2004; 70 FR 60412, Oct. 18, 2005; 74 FR 54455, Oct. 22, 2009; 76 FR 25223, May 4, 2011; 76 FR 70628, Nov. 14, 2011; 77 FR 4216, Jan. 27, 2012]

#### APPENDIX Q1 TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF FLUORESCENT LAMP BALLASTS

Comply with Appendix Q1 beginning November 14, 2014. Prior to this date, all fluorescent lamp ballasts shall be tested using the provisions of Appendix Q.

##### 1. DEFINITIONS

1.1. *AC control signal* means an alternating current (AC) signal that is supplied to the ballast using additional wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

1.2. *Active Mode* means the condition in which an energy-using product—

- (a) Is connected to a main power source;
- (b) Has been activated; and
- (c) Provides 1 or more main functions.

1.3. *Cathode heating* refers to power delivered to the lamp by the ballast for the purpose of raising the temperature of the lamp electrode or filament.

1.4. *Commercial ballast* is a fluorescent lamp ballast that is not a residential ballast as defined in section 1.13 and meets technical standards for non-consumer radio frequency lighting devices as specified in subpart C of 47 CFR part 18.

1.5. *DC control signal* means a direct current (DC) signal that is supplied to the ballast using additional wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

1.6. *High-frequency ballast* is as defined in ANSI C82.13 (incorporated by reference; see § 430.3).

1.7. *Instant-start* is the starting method used instant-start systems as defined in ANSI C82.13 (incorporated by reference; see § 430.3).

1.8. *Low-frequency ballast* is a fluorescent lamp ballast that operates at a supply frequency of 50 to 60 Hz and operates the lamp at the same frequency as the supply.

1.9. *PLC control signal* means a power line carrier (PLC) signal that is supplied to the ballast using the input ballast wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

1.10. *Programmed-start* is the starting method used in programmed-start systems as defined in ANSI C82.13 (incorporated by reference; see § 430.3).

1.11. *Rapid-start* is the starting method used in rapid-start type systems as defined